Testing the Effectiveness of Interventions on Waste Management Behavior in University Sorority Houses

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ABSTRACT

The concept of waste diversion has emerged in response to growing resource consumption and landfill usage. Waste diversion refers to redirecting waste from landfills to reuse programs, composting, or recycling. Changing consumer behavior to optimize waste diversion efforts has been difficult because the motivators and reasoning for waste management behavior are largely unknown. This study aimed to identify the waste management behavior of sorority women at UC Berkeley and whether two specific intervention types, educational programming and bin signage, could significantly increase their waste diversion. To quantify the sorority chapters' waste management behavior, I conducted waste audits before and after an intervention trial period, which allowed me to derive a contamination rate. I also administered surveys before and after the intervention to understand the demographics of the study site, perceived waste management behavior, and feedback regarding the interventions. I found no significant difference between the effects of each intervention. I also found no significant difference between the pre-intervention and post-intervention contamination rates overall, in the signage intervention, and in the education intervention. I learned from surveys that demographics and environmental beliefs are related, signage is useful but customization would be helpful, and there is a difference in perceived and actual behavior. Based on these results, I concluded that my sample size was too limited, both in number of chapters studied and the amount of waste audited within each chapter. Further research on a larger sample with more varied interventions is necessary to adequately understand the waste management behavior of a given population.

KEYWORDS

Environmental education, recycling, composting, waste audit, waste diversion

INTRODUCTION

Poor waste management practices and growing global population have resulted in increasing amounts of landfill waste (Chen and Tung 2009). As the world population has grown exponentially, the consumption of resources has as well (Luten 1991). Rapid resource consumption generates copious amounts of waste that until recent decades have ended up in landfills (Bai and Sutanto 2002). The United States alone produced 250 million tons of solid waste in 2010 (EPA 2011). This combination of rapid consumption and poor waste management creates an ever-present demand for resources such as wood, petroleum, and rare earth elements. This demand, also caused by feeding more people and increasing the standard of living in many places, is not currently sustainable as more resources are becoming scarce (Heinen and Low 1993). In addition to enabling an unsustainable style of resource consumption, landfills also lead to environmental pollution problems. For example, leachate is a highly toxic liquid resulting from the breakdown of waste and methane is a greenhouse gas emitted from decomposing organic material (Bariaz et al. 1997). Issues associated with rapid resource consumption and landfill usage present a need for improved waste management in the United States.

The concept of waste diversion has been developed in response to increasing resource demand, overuse of landfills, and the byproducts of landfill use. Waste diversion redirects post-consumer waste from landfills through measures known as source reduction, recycling, reuse, or composting (or a combination of these measures) (Ferrara and Missios 2005). As the cost and environmental impacts related to using landfills have increased, lawmakers, environmentalists, and consumers are looking to recycling and composting as a means of diverting municipal solid waste from the landfill (Anex et al. 1994). Despite this recent interest, much of the recyclable or compostable solid waste disposed of in the U.S still ends up in landfill. Of the 250 million tons of municipal solid waste generated in America in 2010, food scraps represented 14%, paper 29%, and plastics 12%. Americans composted 3.9% of the food waste generate and recycled 65.6% and 8.3% of the paper and plastic waste generated, respectively (EPA 2011). These figures convey that Americans are not sustainably sorting and managing their trash.

These broad waste management trends can be studied on a smaller scale and in specific communities to determine areas needing improvement, such as infrastructure and education. This technique can be seen in Hirst's study of energy use in institutional buildings in Minnesota to draw

broader conclusions about energy use in commercial buildings (1982). College campuses, the University of California, Berkeley for example, are an example of the small-scale study sites. At the UC Berkeley the diversion rates (percentage of all waste diverted from a landfill) for 2009, 2010, and 2011 were 42%, 41%, and 46% respectively. In each of these years, UC Berkeley has sent 5,000 tons of waste to landfills (UC Berkeley Office of Sustainability 2012). Although waste diversion techniques, like recycling and composting, are more common, we are not fully utilizing them. Based on my observations of waste disposal at UC Berkeley and feedback given by students and staff, I attribute this to a lack of infrastructure on campus, such as composting and recycling facilities, and a lack of education on proper waste management. More understanding of waste management behavior is necessary to create effective diversion policy and campaigns and help relieve the adverse effects of landfills on the environment.

The Greek sorority community of American universities offers an opportunity to gain insight into waste management behavior. Most sorority members throughout the nation reside in large houses, which can house to up to 100 women (NPC 2012). Many organizations are now looking to groups in higher education to create sustainable solutions to environmental problems (Stewart 2010). Changing the waste management behavior of sorority women will not only affect the waste diversion of four million citizens but could also influence others on campus (Janosik et al. 2011). In this study, I will investigate whether interventions can change the waste management behavior in social sorority houses on the UC Berkeley campus. I will test whether the interventions (educational material and bin signage) increase, decrease, or have no effect on the amount of recyclables and compostables disposed of in the trash bin. I hypothesize that the bin signage intervention will result in the largest decrease in the amount of contamination in the landfill bins as compared to the education intervention. Additionally, I will survey the sorority chapters to understand perceived behavior and receive feedback and opinions of the interventions.

METHODS

Site description/study subject

I conducted my research in ten social Greek sorority houses of the University of California, Berkeley in Berkeley, California. I chose to only study the ten houses that practiced both

composting and recycling: Alpha Chi Omega, Alpha Delta Pi, Alpha Omicron Pi, Alpha Phi, Delta Delta Delta, Delta Gamma, Gamma Phi Beta, Kappa Alpha Theta, Kappa Kappa Gamma, and Pi Beta Phi. These houses are located within 0.1-0.3 miles of the UC Berkeley campus. The houses consist of gathering rooms, commercial sized kitchens, communal dining rooms, two to four floors of living space with ten to twenty rooms and a bathroom on each floor. Hired chefs prepare and cook meals, but the women are responsible for their waste disposal. These houses are large, with occupancies ranging from 50-80 women, between the ages of 19 and 22. I conducted my study during the Fall 2013 and Spring 2014 semesters.

Data collection

Pre-Intervention survey

To determine which chapters received which treatment, I administered an electronic survey to each woman of the ten selected chapters that focused on demographics, interests, and waste management knowledge. My survey collected data on age, year, major, perceived waste management behavior, and each woman's opinions of the current state of waste management in their houses. I collected this data to make connections between demographics and perceived waste management behavior and actual waste management behavior, which I measured with the waste audits. My survey had ten questions – five demographic based questions and five opinion based questions. I created multiple choice, free response, and Likert scale questions. I collected responses from this survey in December 2013. I analyzed the baseline contamination rate, number of College of Natural Resources majors, and perceived waste management behavior based on the Likert scale questions to determine two treatments groups.

Interventions

To determine which interventions elicit change in waste management behavior, I deployed a different intervention for each treatment group. The two interventions I administered in this study were detailed bin signage and education material. I deployed the interventions for a one-month period at the beginning of the Spring 2014 semester. For the bin signage, I created color-coded

signage with images of common items corresponding to each waste stream. Colors indicated waste type: black corresponded to landfill, blue to mixed paper and bottles and cans (two separate streams), and green for compost. I placed signs near every communal bin in the house. For the other intervention, educational outreach, I presented a PowerPoint presentation at each chapter's mandatory weekly meeting. In this presentation I explained each waste stream and the importance of practicing sustainable waste management behavior. To convey this point, I discussed the negative aspects of landfills such as leachate and methane creation, how our non-renewable resources are diminishing, and how much "landfill" waste can be diverted to recycling or composting. Through the intervention period, I received updates and observations through constant contact with the Sustainability Chair of each chapter.

Waste audits

To quantify the landfill contamination rates of each chapter, I conducted waste audits. I performed a waste audit at each chapter before the intervention and one week after the intervention period. A waste audit is an analysis of the contents of a landfill bin. I sorted the contents of the landfill into the four waste streams and then used a scale to collect weights (in pounds) of each category (landfill, mixed paper, bottles and cans, and compostables). In this study, bottles and cans consisted of glass, metal, and plastics. The audit I conducted before the intervention provided the baseline waste management data. I performed an audit immediately after the completion of the intervention to measure the immediate influence of the intervention. For each house, I conducted the two audits on the same day of the week and a similar time of day for each set of data to be comparable.

Post-Intervention survey

Finally, I administered a post-intervention survey with open-ended questions to the women of each chapter to collect feedback regarding the interventions and perceived changes in waste management behavior. In the survey, I asked about each woman's recycling and composting frequency. I then compared this to the actual waste audit data to see if there was a discrepancy between a chapter's reported recycling and composting rates and their waste audit data. In addition,

during and after the interventions I interviewed each chapter's sustainability chair on how the chapter received the interventions and the overall waste management culture in the house.

Data analysis

Pre-Intervention analysis

I analyzed the data from the pre-intervention demographic survey and the preliminary waste audits to aid the intervention assignment process. After conducting pre-intervention waste audits on each of the chapters, I ranked them from 1 to 10, with 1 being the lowest contamination and 10 the highest contamination rate. I defined contamination rate as the total of the compostables and recyclables percentages found in the landfill bin. For the survey results, I scored each chapter based on their number of women with majors in the College of Natural Resources and each woman's response to the Likert questions (5 point rating scale). I segregated by majors because those in the College of Natural Resources are environmentally based and women majoring in those subjects are likely to have more knowledge and/or passion about sustainability. I ranked the chapters based on the number of women in majors in the College of Natural Resources and incorporated this ranking into each chapter's perceived and demonstrated wastefulness ranking. Some examples of the Likert questions I included are: 'How often do you compost in your sorority house' (1 being Never, 5 being Always) and 'How strongly do you agree with this statement: The women in my chapter care about recycling and are informed on how to do so properly' (1 being Strongly Disagree, 5 being Strongly Agree). Lastly, I ranked the chapters based on their overall average response to the five Likert questions. I averaged the three rankings, baseline contamination, the number of College of Natural Resources majors, and perceived waste management behavior, to create an overall ranking of perceived and demonstrated wastefulness. In this ranking, the highest ranked chapter exhibited the lowest demonstrated wastefulness and the highest sustainable waste management awareness. With this ordered list, I alternated interventions; for example, the highest ranked chapter received signage, the second ranked chapter received education, the third ranked chapter received signage, and so on. I randomly selected which intervention the highest ranked chapter received.

Waste audit data analysis

To quantitatively compare the landfill contamination rates of each the houses, I used the data from the waste audits and converted all of the weights to proportions. Proportionality allowed me to control for occupancy and compare between each house. I graphed the proportions of landfill, mixed paper, bottles and cans, and compostables for each chapter for before the intervention (baseline) and one week after the completion of the intervention. My comparison of these two values determined the overall influence of a specific intervention in each chapter and in the sorority system in general. To determine whether there was a significant difference in the change in contamination rate elicited by each intervention, I used the Kruskal-Wallis non-parametric test. To determine whether there was a significant difference in the baseline and post-intervention contamination rates overall and within each intervention, I used the Paired Samples Wilcoxon non-parametric test (R Commander). I used non-parametric statistical tests due to the small sample size of my study.

RESULTS

Pre-Intervention survey results

In the pre-intervention survey, a total of 216 sorority women responded and the majority of women thought composting and recycling was a common practice for themselves and their chapter (Table 1). Two chapters, Alpha Delta Pi and Pi Beta Phi, did not have any survey respondents. Similarly, Kappa Kappa Gamma only had one respondent. This is a result of their Sustainability Chairs not circulating the survey to their respective chapters. Most of the women who responded to the survey reported a hometown in Southern California or in the San Francisco Bay Area. In each chapter's respondents, I found a few women from out of state and international. The average age and year in school for all the chapters was about 19.5 years and 2.4 years, respectively. Common majors were also pretty similar between each chapter with several respondents reporting Psychology, Public Health, and Molecular and Cell Biology as their majors (Table 1). All of the chapters, with the exception of Delta Gamma, on average reported a higher perceived behavior of composting than recycling, both on an individual and chapter-wide level.

Every chapter averaged a 4.1 or higher in agreeing to knowing how to differentiate each waste stream. (Table 2).

Table 1. Summary of demographic data for each chapter.

Chapter	Number of Respondents	Average Age (years)	Average Year in School	Common Majors
Alpha Chi Omega	29	19.4	2.3	Society and Environment
Alpha Delta Pi	0	N/A	N/A	N/A
Alpha Omicron Pi	36	19.8	2.7	Public Health, Political Economy
Alpha Phi	17	19.4	2.1	Public Health
Delta Delta Delta	39	19.6	2.6	Integrative Biology, Environmental Science, Psychology
Delta Gamma	36	19.6	2.4	Media Studies, Psychology
Gamma Phi Beta	18	19.5	2.4	Molecular and Cell Biology
Kappa Alpha Theta	29	19.5	2.5	Psychology, Molecular and Cell Biology
Kappa Kappa Gamma	1	20	3	Environmental Economics and Policy.
Pi Beta Phi	0	N/A	N/A	N/A

Table 2. Summary of perceived waste management behavior for each chapter. Questions were asked in Likert form, with responses ranging from 1-5 (1 for never or strongly disagree and 5 for always and strongly agree). The responses for each question were averaged for each chapter.

Chapter	How often do you recycle in your sorority house?	How often do you compost in your sorority house?	I can differentiate which items belong in each of the four bins.	The women in my chapter care about recycling and are informed on how to do properly.	The women in my chapter care about composting and are informed on how to do properly.
Alpha Chi Omega	4.6	4.9	4.5	4.3	4.3
Alpha Delta Pi	N/A	N/A	N/A	N/A	N/A
Alpha Omicron Pi	4.3	4.5	4.3	3.8	3.8
Alpha Phi	4.4	4.9	4.1	3.9	4.1
Delta Delta Delta	4.5	4.8	4.2	3.9	3.9
Delta Gamma	3.3	2	4.1	3.3	2.7
Gamma Phi Beta	4.2	4.7	4.1	4	4.2
Kappa Alpha Theta	4.5	4.6	4.4	4	4
Kappa Kappa Gamma	5	5	5	4	4
Pi Beta Phi	N/A	N/A	N/A	N/A	N/A

Intervention results

I received mostly positive feedback from the sustainability chairs and chapters about the interventions and their effectiveness. Several women noted that the educational presentation was both enjoyable and informative. Some stated that although the presentation was entertaining and helpful, they wanted a more permanent reminder of how to practice sustainable waste management. The majority of the feedback with respect to the signage was positive; the women felt that a standardized and color-coded sign system was beneficial. The only critique was that there could be more items on the sign to make sorting easier.

Waste audit results

I found that the landfill contamination rates decreased in a majority of the houses after the interventions were deployed. The baseline waste audit data spanned a considerable range, with contamination rates from 43% to 77% (Table 3). The post-intervention waste audits had a similar range of contamination rates, 47% to 77% (Table 4). Common items found in both audits include paper products (plates, napkins, boxes), food, compostable plastics, #1 PET plastic cups, cans, and tea bags. I found the difference in contamination rate in each house, and attempted to explain the outlier values (Table 5).

Table 3. Baseline waste audit data for each chapter

Chapter	Percent of Bottles & Cans	Percent of Compost	Percent of Landfill	Percent of Mixed Paper	Contamination Rate
Alpha Chi Omega	10	40	50	0	50%
Alpha Delta Pi	31	46	23	0	77%
Alpha Omicron Pi	0	67	33	0	67%
Alpha Phi	10	40	50	0	50%
Delta Delta Delta	14	29	57	0	43%
Delta Gamma	1	71	28	0	72%
Gamma Phi Beta	1	65	33	1	67%
Kappa Alpha Theta	5	42	53	0	47%
Kappa Kappa Gamma	14	48	38	0	62%
Pi Beta Phi	10	50	40	0	60%

Table 4. Post-intervention waste audit data for each chapter

Chapter	Percent of Bottles & Cans	Percent of Compost	Percent of Landfill	Percent of Mixed Paper	Contamination Rate
Alpha Chi Omega	7	40	53	0	47%
Alpha Delta Pi	5	50	45	0	55%
Alpha Omicron Pi	9	55	36	0	64%
Alpha Phi	0	40	60	0	40%
Delta Delta Delta	6	71	23	0	77%
Delta Gamma	0	71	29	0	71%
Gamma Phi Beta	4	55	41	0	59%
Kappa Alpha Theta	13	53	34	0	66%
Kappa Kappa Gamma	27	33	37	3	63%
Pi Beta Phi	0	67	33	0	67%

Table 5. Situational analysis of waste audit data

Chapter	Intervention	Change in Contamination Rate (%)	Unique Circumstances
Alpha Chi Omega	S	-3	Catered chapter event in the days prior to the baseline waste audit, included items that are not normally purchased for the house
Alpha Delta Pi	S	-22	Small sample size in baseline waste audit
Alpha Omicron Pi	S	-3	
Alpha Phi	E	-10	Small sample size in both waste audits
Delta Delta Delta	E	+34	
Delta Gamma	S	-1	In baseline audit, had compost bins in the house but did not put compost in carts outside
Gamma Phi Beta	E	-8	
Kappa Alpha Theta	E	+19	Baseline waste audit was done on weekend while the post-intervention audit was done on a weekday
Kappa Kappa Gamma	S	+1	
Pi Beta Phi	E	+7	Small sample size in post-intervention waste audit

Pre-Intervention survey analysis results

Through analysis of the baseline waste audit data and pre-intervention survey, I assigned Alpha Chi Omega, Alpha Omicron Pi, Kappa Kappa Gamma, Delta Gamma, and Alpha Delta Pi to the signage intervention and Delta Delta Delta, Kappa Alpha Theta, Alpha Phi, Gamma Phi Beta, and Pi Beta Phi to the education intervention. Delta Delta Delta had the lowest baseline contamination rate at 43% while Alpha Delta Pi had the highest at 77% (Table 6). These rankings combined with the perceived waste management rankings and baseline environmental knowledge

rankings (as determined by major classification; Table 7) provided an overall perceived and demonstrated wastefulness ranking for each chapter. The top five group, meaning the least wasteful and most environmentally aware, consisted of: Delta Delta Delta, Alpha Chi Omega, Kappa Alpha Theta, Alpha Omicron Pi, and Alpha Phi. The bottom five group consisted of: Gamma Phi Beta, Kappa Kappa Gamma, Delta Gamma, Pi Beta Phi, and Alpha Delta Pi (Table 8).

Table 6. Chapters ranked based on baseline contamination rate

Ranking	Chapter	Baseline Contamination Rate
1	Delta Delta Delta	43%
2	Kappa Alpha Theta	47%
3	Alpha Phi	50%
3	Alpha Chi Omega	50%
5	Pi Beta Phi	60%
6	Kappa Kappa Gamma	62%
7	Alpha Omicron Pi	67%
7	Gamma Phi Beta	67%
9	Delta Gamma	72%
10	Alpha Delta Pi	77%

Table 7. Chapters ranked based on number of CNR majors reported in survey

Ranking	Chapter	Number of CNR Majors
1	Alpha Chi Omega	10
2	Delta Delta Delta	4
2	Alpha Omicron Pi	4
4	Delta Gamma	3
5	Gamma Phi Beta	2
5	Kappa Alpha Theta	2
7	Kappa Kappa Gamma	1
7	Alpha Phi	1
9	Pi Beta Phi	No Survey Responses
9	Alpha Delta Pi	No Survey Responses

Table 8. Overall perceived and demonstrated wastefulness ranking, pre-intervention. With 1 being the most sustainable and waste management conscious, and 10 being the least.

Ranking	Chapter
1	Delta Delta Delta
2	Alpha Chi Omega
3	Kappa Alpha Theta
4	Alpha Omicron Pi
5	Alpha Phi
6	Gamma Phi Beta
7	Kappa Kappa Gamma
8	Delta Gamma
9	Pi Beta Phi
10	Alpha Delta Pi

Post-Intervention survey results

The post-intervention survey revealed that a majority of the women found the bins signs to be helpful, but not as effective if they had more specific images on them. Some responses to the question of the helpfulness of bin signs include: "I think that they would make waste sorting easier if they have pictures on them of exactly what we use in our house" and "be specific to events, like for a philo [philanthropy] event saying what goes where." Several women noted that lack of bin availability and laziness deterred them from composting and recycling. Lastly, there was a split in responses on which kind of programming would encourage composting and recycling. Some women felt that competitions are effective while others think competitions are too lengthy and hard to sustain interest, so a game of some kind is preferable. Overall, 83 women participated in the survey.

Waste audit data analysis results

By using non-parametric statistical tests, I determined there was not a statistical significance overall or within each intervention between the baseline contamination rate and the post-intervention rate. Also, there was not a significant difference of change in contamination rate between the two interventions. According to the Kruskal-Wallis test, there was no significant

difference between the change in contamination rate of the signage intervention and of the education intervention (df=1, P= 0.3457). According to the Paired Samples Wilcoxon test, there was no significant difference between the pre-intervention contamination rate and the post-intervention contamination rate for the overall study (W=30.5, p= 0.7986). With this same test, I found that there was no significant difference in the contamination rate between pre and post-intervention for the education intervention (W=5, p= 0.625). Lastly, I found that there was no significant difference in the contamination rate between pre and post-intervention for the signage intervention (W=13.5, p= 0.1344).

DISCUSSION

The statistical results of my study suggest that the signage and education intervention did not significantly decrease the contamination rate in the ten sorority chapters. This lack of significance can be attributed to small waste audit samples, ineffective interventions, or outlier chapters. Although there was no significance in the waste audit data, the pre and post-intervention surveys revealed that the women overwhelmingly care about composting and recycling but feel that it is difficult to do correctly. The results from this study do not provide a conclusive answer to which interventions are effective in lowering the contamination rate. However, the study has implications for future education and outreach efforts and opens the possibility for further exploring the effectiveness of a variety of interventions in eliciting a change in consumer behavior.

Demographics and knowledge on waste management behavior

Based on the demographic results that I collected from my study site, college aged sorority women in Northern California consider waste management a priority. Each chapter had very high averages in response to caring about recycling and composting, which can be demonstrating that the women believe it an important issue even if they do not always practice waste management correctly. Within the ten chapters, houses with a high proportion of women in majors in the College of Natural Resources, such as Delta Delta Delta and Alpha Chi Omega, had lower pre-intervention contamination rates. A higher number of women in the College of Natural Resources could imply a higher consciousness of environmental issues and willingness to learn how to mitigate these

issues, which Emmelin feels is necessary for the long-term success of environmental policies. Environmental education is necessary for inciting a feeling of individual responsibility for the state our planet is in (1977). Therefore, is it reasonable to assume that students studying an environmental field will feel a greater need to be proactive, which in this case means properly recycling and composting.

In general, the demographics of a certain population will directly mold the opinions and beliefs of that group (Hakli and Negri 2011). UC Berkeley is located in Berkeley, CA, a city known for its liberal roots and movements in causes such as worker's rights, free speech, and environmental sustainability (Ghasarian 1996). This environment and the demographics of the population who study, work, and live here influence the priorities and beliefs of the citizens. Because of this, a majority of Berkeley students feel a call to action to solve a problem and a feeling of responsibility for the planet and the less fortunate people who inhabit it. However, Berkeley makes up only a small percentage of the national population, 0.03% (U.S. Census Bureau 2012). For example, in Ferrara and Missios study in Ontario, Canada, implementing a fee for landfill disposal was deemed the most successful intervention in increasing the recycling intensity of its citizens (2005). On the other hand, Hopper and Nielsen found that in Denver, Colorado, people were motivated to engage in sustainable waste management behavior by imposing social norms (1991). The Hopper and Nielsen study affirms that the social norms of a particular culture shape the waste management behavior of the members of that culture. Essentially, the effect of various interventions is largely based on the demographics of the study population.

Overall effect of interventions on waste management behavior

Neither intervention significantly decreased the contamination rate, suggesting that the piloted efforts were not as influential as desired. This result contradicts the finding of many other studies trying to influence waste management behavior. Several other studies have proven the effectiveness of a variety of interventions. For example, Feldman and Perez observed the implementation of regulations and institutional frameworks and how it successfully altered recycling behavior (2012). Interventions, whether they are signage and education (like in this study) or monetary incentives or fees cause a person to react. The hope is that reaction will elicit a positive change in behavior, which was observed in this study. On the other hand, many studies

have emphasized the importance of personal beliefs in determining an individual's behavior. Individuals need to have ownership of environmental issues and their consequences in order to form an environmentally sustainable lifestyle. Otherwise, individuals do not feel a personal responsibility or connection with the issue and they will not take steps to solve it (Hungerford and Volk 1990). One could argue that this ownership could be inspired by some kind of intervention, such as being educated on the current environmental issues.

Although the findings of this study differ from those of many others testing interventions on waste management behavior, some chapters experienced unique waste due to an event or change in pick-up frequency. These situations caused for an inconsistency in data collection and contributed items to the waste stream that are abnormal for that chapter. A few chapters were outliers, with changes in contamination rate exceeding 10%. This includes Alpha Delta Pi (-22%), Delta Delta Delta (+34%), and Kappa Alpha Theta (+19%). The outliers essentially cancelled each other out, leaving a statistically insignificant result.

Comparison of interventions on waste management behavior

Signage did not significantly decrease the contamination rate of the assigned five chapters, proving my hypothesis to be incorrect. My post-intervention survey allowed me to identify possible shortcomings in each of the interventions and in my study design overall. While my study used only one type of standardized signage many variations are possible; for example, Byerly et al. tested signs with different messages and tones (2009). Specifics like this must be known in order to change behavior to the largest possible degree. The women who responded to the post-intervention survey echoed this sentiment and felt that the signage would have been more effective if the images on the sign reflected items that were purchased and consumed in their respective house. Customized and comprehensive signs would make sorting into the four waste streams more clear. This request reveals a very important factor of behavior: convenience. Students at Massey University in New Zealand overwhelmingly agreed that inconvenience was their main deterrent from recycling (Ganesh et al. 2006). A study of a recycling plan in Massachusetts also concluded that recycling rates would increase significantly if made more convenient (Callan and Thomas 1997). Overall, the signage was received positively, but the feedback provided by the women must be considered in order for the signage to be as effective as possible.

The education intervention also did not significantly decrease the contamination rate, suggested that the content presented did not have lasting impacts on the behavior of the women. An education presentation is not an ever-present reminder of expectations, like the signage is. Many of the survey respondents commented that outreach efforts like educational presentations and competitions are good in theory, but have limited long lasting effects. Some women suggested frequent educational events, such as games, to keep people interested and remind them of important waste diversion rules. All in all, behavior change techniques have been widely studied and a general conclusion is that a combination of techniques, such as positive motivational techniques and information techniques, are necessary to influence a population (De Young 1993). With this notion, in order to maximize waste diversion and general waste management knowledge, several approaches need to be implemented. Learning style differs from individual to individual, whether it's verbal or visual (Bjork et al. 2008). To accommodate the spectrum of learning styles and increase actual waste management behavior, infrastructure and outreach efforts must be multi-faceted.

Perceived behavior versus actual behavior

As expected, the perceived waste management behavior recorded in the surveys differed from the actual waste management behavior recorded in the two waste audits. Discrepancies in results in self-reported tests are accounted for by response bias (Arnold and Feldman 1981). Essentially, response bias refers to the phenomenon where individuals respond to questions with what they believe the questioner wants to hear or what the individual perceives as the right answer (Marquis et al. 1986). In this case, the 'desirable' response would be indicating that the individual has a strong concern for waste management and takes action to remedy this issue. In my study, the chapters overwhelmingly responded in this manner in their surveys. However, the contamination rate**,** the proportion of recyclables and compostables in the landfill, was at least 40% in every house before and after the interventions. So, the women may care about waste management, but the appropriate action has not been taken in the houses. I am able to analyze the perceived behavior and actual behavior results to an extent, but some limits of the study design restrict the inferences that can be made.

Limitations

Applicability of my study's results are limited because of uneven amounts of waste collected in each chapter and demographic differences in communal living spaces in other areas of America. The sample size of waste collected and audited differed from house to house in the pre-intervention audit. In the first audit, the sustainability chair and I audited whatever waste was in the landfill bins in the communal areas of the house. However, each house has a different schedule for emptying the bins. Because I was unaware of the specific schedule for each house, some houses had significantly more landfill waste in their landfill bins than others. Although I compared proportions of waste and not waste weights, larger and even sample sizes are important in order to get a full understanding of the chapter's waste stream and be able to compare the chapters fairly. I corrected for this issue in the post-implementation audits by using a bag of communal landfill waste from the chapter's dumpster which contained more waste and was roughly equal from house to house. In their study of recycling in hotels, Lee and Ralston ran nine trials; my study would have benefited from a larger sample size and more data to compare (2003).

Additionally, the applicability of the results of this study to other regions of America is limited. While my study reveals effective means of changing waste management behavior in sorority houses in Northern California, demographics of sororities and other communal space in other areas are different. For example, polling in various regions of California has revealed that Latinos/Latinas express more concern for the environment than Caucasians. While California has a large Latino/Latina population, other parts of the country do not; therefore other regions' degree of concern for the environmental is possibly much different (Bowler et al. 2005). This limits the inference that can be made in regards to waste management behavior.

Future directions

While this study revealed some valuable information about waste management behavior, further research is needed to identify an extensive list of effective interventions and whether these are applicable in other geographical regions. This study only tested the effects of a specific signage and education intervention. There are several other interventions, such as monetary incentives, that also need to be tested in order to have a comprehensive list of interventions that successfully

increase waste diversion and lower landfill contamination. Additionally, while my study sheds light on the waste management behavior of Northern California college aged women, further research is needed to understand the waste management behavior of college aged Americans in other parts of the country. Even though the age range may be similar in these different regions, other demographics vary widely, which will affect their response to an intervention. Information necessary to understand waste management behavior and how to alter it is still lacking, but the findings from this study do have broader implications that help in understanding waste management behavior in communal spaces.

Broader implications

Although my study was done in a sorority community in Northern California, the findings are applicable to other communal living systems across the country. Although my study's interventions did not see a significant change in contamination rate, valuable feedback pertaining to my choice of interventions and ideas for future efforts was gained. In order to get the college aged population living in dorms, co-ops, and Greek houses to divert as much landfill as possible, influential policies and programs need to be in place. Based on this study, I recommend further research on the effects of increased standardized signage for all bins and frequent educational presentations on how to sort waste correctly and why it is important to work towards this goal of landfill diversion. Additionally, customized signage for each communal space would be especially helpful as I discovered in my audits that each house had items in their waste stream that were unique to that house, like a certain brand and type of plastic cups for example. The feedback and research regarding the signage and education could have applications to other environmental issues such as water usage. A similar test could be performed using water metering, signs with water conservation facts, and educational efforts promoting the reduction of water usage. Increased understanding of environmental behavior and how to alter it will allow for water and waste reduction efforts to be more successful. The copious amounts of landfill waste produced puts a strain on the planet's limited resources while also creating harmful pollutants such as leachate and methane. These recommendations could be viable strategies to help alleviate the stresses of landfill waste contributed by college age Americans.

ACKNOWLEDGEMENTS

This study would not have been possible without the help of my 2013 Sustainability Chairs, the women in their respective chapters, and Elizabeth Avina, who assisted me with the waste audits. Also, my Panhellenic Vice President of Sustainability successor, Hannah Berman, graciously allowed me to continue my thesis work with the sustainability chars when my data collecting unexpectedly continued into the Spring semester. The inspiration for this project came from my work at Campus Recycling and Refuse Services, where I have been fortunate to oversee the most wonderful staff. I am grateful for all of the time and energy that both Kurt Spreyer and Rachael Marzion put into my project. Their constant feedback and support allowed for this thesis to be completed. Lastly, thank you to my fantastic work group: Alex Chou, Michelle Nacouzi, Tara Yavorsky, and Tiffany Tran, who always provided a refreshing enthusiasm, some much needed humor, and helpful edits.

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